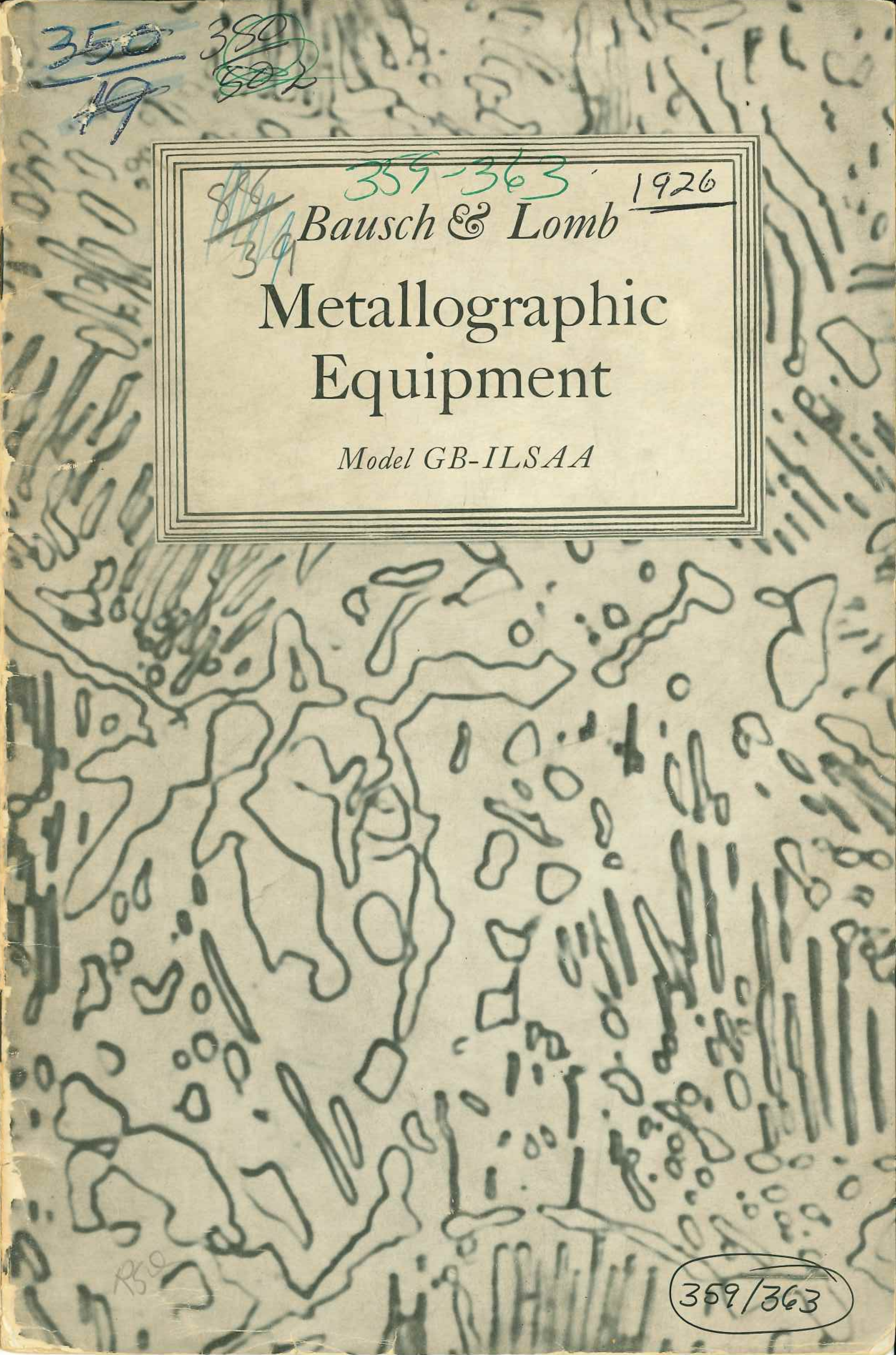

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1926

Bausch & Lomb

Metallographic Equipment

Model GB-ILSAA

359/363

Received in U.S. Patent Office
Dec. 24, 1926

Bausch & Lomb

Metallographic Equipment

Complete Model GB-ILSAA

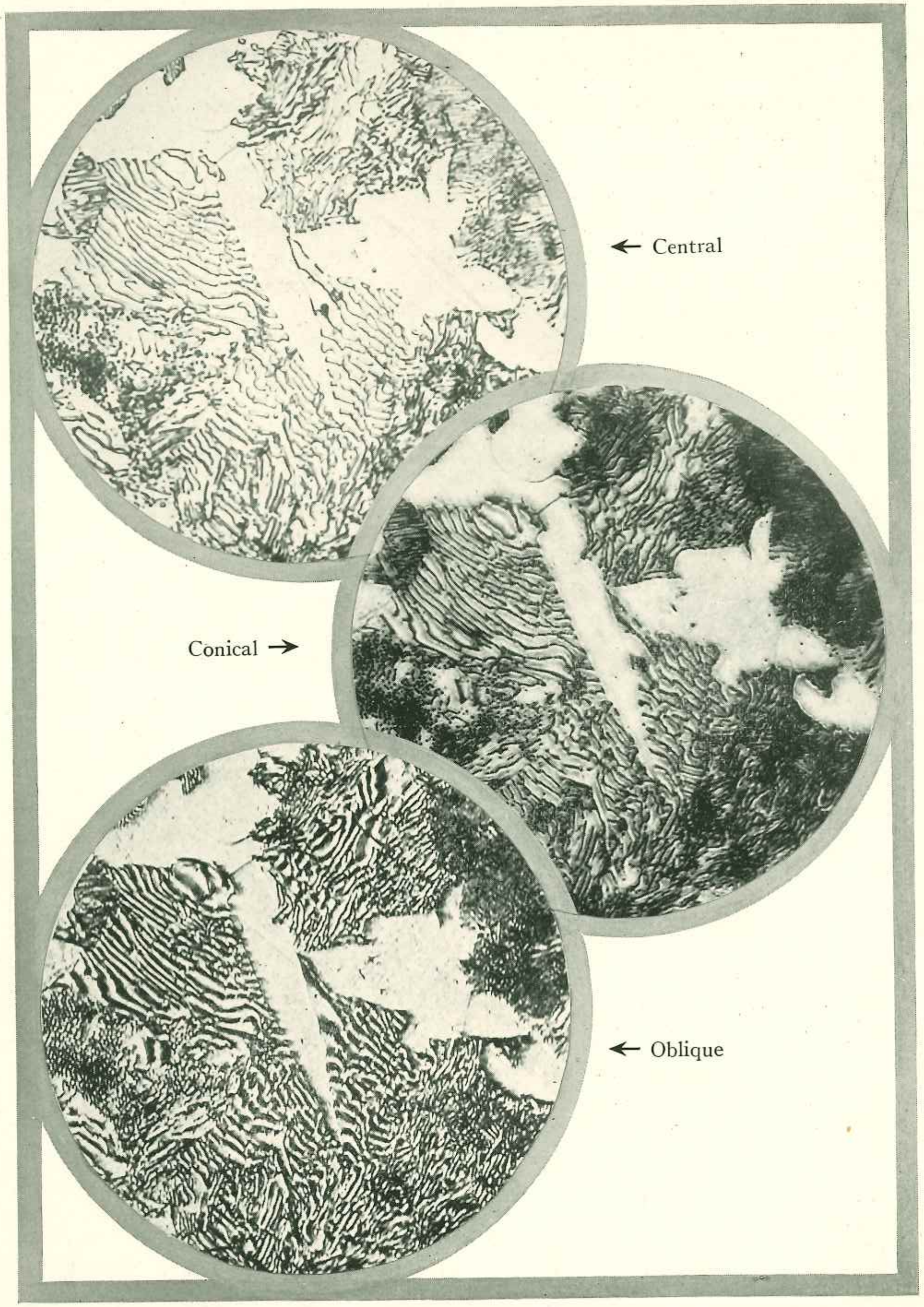
with Inverted Microscope Permanently Aligned with Illuminant

BAUSCH & LOMB OPTICAL COMPANY
Executive Offices and Manufactory
ROCHESTER, NEW YORK

New York Chicago San Francisco London Washington Frankfurt

Three Types of Illumination

These photographs were taken on a Bausch & Lomb Large Metallographic Outfit GB-ILSAA, with Central, Conical and Oblique Illuminations respectively.



Bausch & Lomb
Metallographic Equipment
Model GB-ILSAA

Featuring the Permanent Alignment of Microscope and Illuminating Unit.

THE outstanding success of American industries today has been brought about largely by the adoption of most efficient and economical methods for every manufacturing process. This success depends upon the ability to control all processes exactly and upon the rigid selection of tools and materials. This implies the possession and use of precise information as to the physical properties of all materials, and absolute knowledge regarding the most efficient and economical materials and methods.

For this reason metallography has become of great importance in industry and modern metallographic equipment indispensable to the work of the metallurgist and steel treater. The metallographic camera not only enables the engineer and metallurgist to study systematically the properties of metals and the characteristic changes which they undergo through heat treatment or through other processes, but makes a permanent photographic record of what is observed—an indisputable record, which is often of the greatest value. The metallographic camera facilitates the selection of the proper material for each task in the manufacturing process—and eliminates much of that most serious kind of waste—time spent unnecessarily in working on the wrong grade of material or with the wrong tools.

American Made Throughout

The very purposes to which the metallographic camera is put are characteristic of the Bausch & Lomb Metalloscope and Metallographic Camera. This instrument has been designed and built for American industries by an American industry—America's leading optical institution—with the one purpose of giving the maximum in results with the minimum expenditure of time and effort, and is characterized by the very attributes which mark the success of the industries using it.

It is designed to be as simple in operation and use as it is possible to make it without sacrificing any of the essential features or refinements that contribute to its successful use.

Conforms to A. S. T. M. Standards

The Bausch & Lomb Metalloscope has been built in conformity with the requirements of the American Society of Steel Treaters, and of the American Society for Testing Materials; and it meets in every particular the requirements for metallographic equipment as laid down in the standards of the A. S. T. M. The Bausch & Lomb Metalloscope is designed more particularly for the use of metallurgists and engineers than for microscopists.

Metallographic Equipment

The complete Bausch & Lomb Metalloscope consists essentially of:

(1) The inverted microscope and illuminating system mounted as a permanently aligned unit.

(2) Camera and camera support.

(3) Shock absorbers and stand.

The entire equipment forms a complete metallographic camera of almost unlimited capabilities. It is flexible where flexibility is needed, but with all unnecessary and superfluous movements eliminated.

Unit Construction of Inverted Microscope and Illuminating System

One feature of the Bausch & Lomb Metalloscope which is greatly appreciated is the permanent alignment of the microscope and illuminating system (Figure 2).

In the earlier models of our Metalloscope, provision was made for varying distance between the illuminant and the microscope—for raising and lowering the illuminant independently of the microscope, and for lateral movement. These adjustments were provided with a view to giving the instrument great flexibility, so that it might be adapted to every possible requirement. Experience has shown, however, that the best performance of the instrument can be obtained only when the entire optical system is accurately aligned, properly centered and correctly located.

Experience has also shown that the most tedious and difficult part of the task of using the metallographic camera was that of getting the optical system into proper optical adjustment. When once the instrument had been centered there was no further need of altering the relative positions of microscope and illuminant—but whenever, through accident or carelessness, the adjustment was disturbed, it became necessary to repeat the work of aligning the optical parts.

All of this difficulty has been eliminated in the Bausch & Lomb Metalloscope. The optical parts of microscope and illuminating system are accurately centered and aligned at the factory and are permanently mounted in their proper relative positions.

While our experience and the experience of many of the users of these large metallographic equipments has proven the logic of the permanently aligned and precentered type of construction, we are prepared to supply on special order the illuminating unit on separate base and standard with adjustments for height and inclination.

Inverted Microscope—Type IL

The Inverted Microscope is of the type suggested by Le Chatelier for the microscopic examination and photomicrography of opaque objects by means of vertical or oblique illumination in conjunction with a vertical illuminator and an appropriate illuminating system. The stage, which is above the microscope tube, carries the object with its flat surface downward. This stage is provided with a two-way compound slide movement.

The entire stage of the IL Microscope is supported at its four corners by a sturdy unit casting, which in turn is supported at its center. This construction is far superior to the method of supporting the microscope stage from one edge. It assures permanent parallelism between the plane of the specimen and the focal plane of the microscope, regardless of the size or weight of the object. If the optical axis of the microscope is not accurately perpendicular to the plane of the specimen, a falling off in definition on one side of the image results.

Focusing is accomplished by rack and pinion adjustments acting directly upon the stage. The objective, which is permanently aligned in its correct position with respect to the optical axis, is never moved. The vertical column supporting the stage and unit base are provided with unusually broad bearing surfaces so that large and heavy specimens will not interfere with easy and accurate focusing. Coarse adjustments are made by means of a large wheel which actuates the rack and pinion movement. Fine adjustments are made either with a micrometer screw or a focusing rod from the plate end of the camera.

A very convenient feature of this instrument is the engraved scale on the rack slide by which the position of the stage can be quickly set for different objectives so that they will immediately be brought into approximate focus.

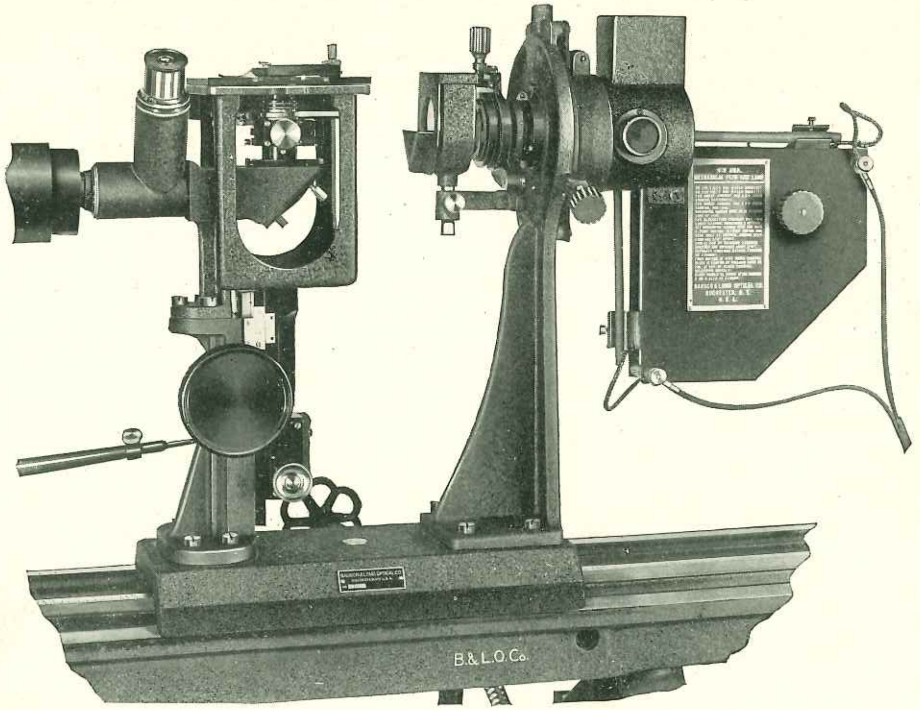


Figure 2.—Metalloscope ILSAA, showing permanent alignment of the axis of condensing lens system on illuminating unit with center of vertical illuminator.

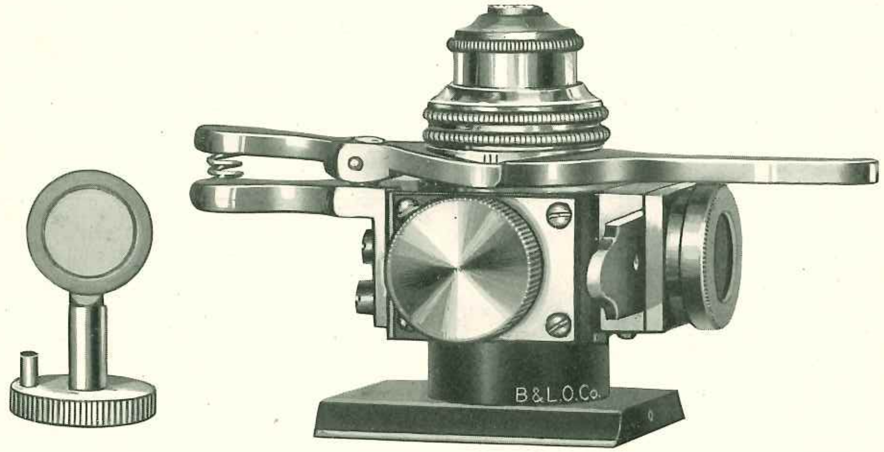


Figure 3.—Vertical Illuminator, with side tube and condenser, sliding diaphragm with four apertures and ray filter, giving practically monochromatic light.

Vertical Illuminator

The vertical illuminator (Figure 3) is fitted with a sliding plate by means of which it may be removed from the microscope if desired. It is centered with reference to rotation about its vertical axis and locked in position. A stop is also adjusted to assure one that the clear glass reflector is at exactly 45° to the axis of the objective. For those desiring greater illumination, or oblique illumination with lower power, a semi-circular mirror is supplied to interchange with the clear glass reflector.

The opening in the side of the vertical illuminator is fitted with a short tube in which is mounted a small condensing lens, a sliding diaphragm with four apertures and two glass filters. These filters produce approximately monochromatic light equivalent to the E line of the mercury spectrum, which is the wave length for which the achromatic objectives are corrected and which we have found to be the most satisfactory for general metallographic work, particularly for iron and steel. To those desiring other filters, we suggest a selection from the set of Wratten "M" filters (see page 17), in which case we can supply a holder fitted to the front of the condenser mount on the illuminating unit.

The full numerical aperture of the objective may be used, or the aperture may be reduced by selection of the opening in the sliding diaphragm. The maximum resolution with any objective will be obtained when the largest size aperture is used. The flatness of the field can be increased, with a sacrifice of resolution, by using the smaller openings in the sliding diaphragm. The ILS Metalloscope can be diaphragmed down to give a flat field—but in no photomicrographic outfit, metallographic or otherwise, can full resolving power and perfectly flat field be had at the same time.

Illuminating System

The illuminating system is rigidly supported by a sturdy stand that is a unit with the stand of the inverted microscope. The three-element condensing system is thus permanently aligned with the center of the supplementary condenser on the side of the vertical illuminator. This permanent alignment makes perpetual "lining up" of the optical system unnecessary. The only adjustment necessary is to bring the light source into alignment with the axis of the condensing system, which is easily done by means of two centering screws.

The condensing lens is fixed in place for all objectives at the position of greatest efficiency. No advantage is gained in changing condensers, as each objective acts as its own condenser in vertical illumination.

An iris diaphragm in a rotating mount with decentering adjustment by rack and pinion makes possible the illumination of the specimen by *oblique illumination* from any direction and a central stop provides for *conical illumination*. (See Figure 2.)

The small cell directly in front of the condensing system may be used either as a water cell for protecting the Wratten filters when they are used on the holder on the front of the cell, or it may be used as a liquid filter cell.

Illuminants

The source of light may be either an Automatic Feed Arc Lamp (used with a suitable rheostat) or a 6-volt, 108-watt ribbon filament Mazda lamp. The clock feed mechanism of the arc lamp operates the carbon holders by means of a constant chain drive, maintaining a steady and uniform arc of high intensity. The excursion of the carbon holders is sufficient to accommodate the full length of 6″ carbons with one setting—giving nearly two hours of steady light. It must be remembered, however, that the arc will waver, due to inherent inequalities in carbon, and that an occasional

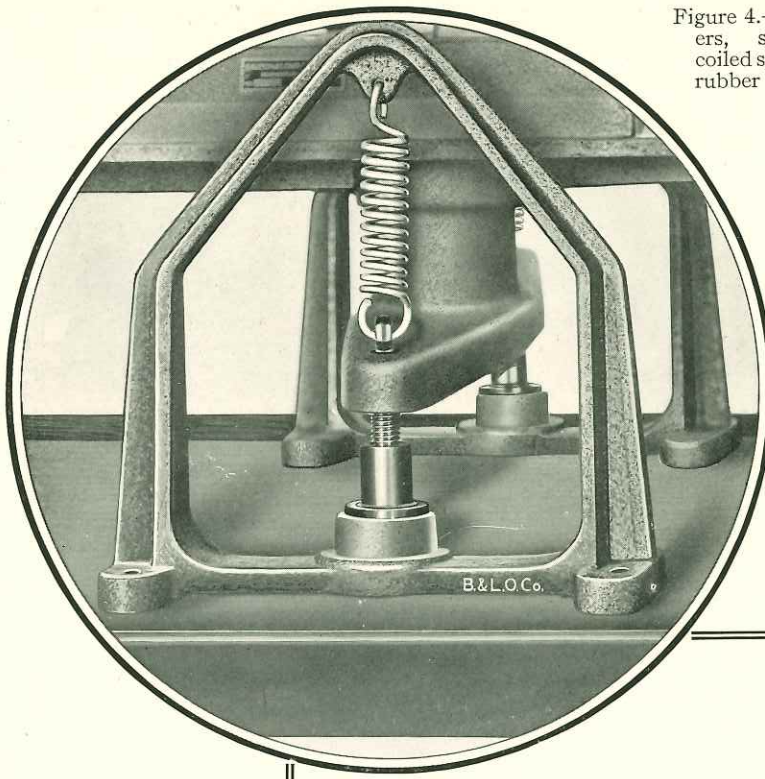


Figure 4.—Shock Absorbers, showing frame, coiled spring and sponge rubber damper.

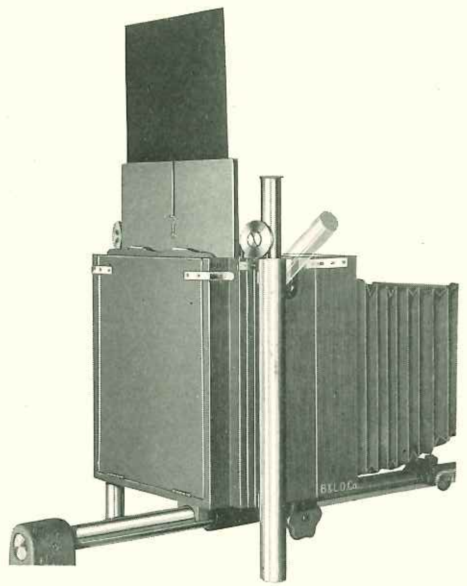


Figure 5. — Supplementary plate holder and viewing device with viewing tube (phantom) tilted into position.

adjustment of the arc will be necessary inasmuch as the carbons are fed by the clockwork at a constant rate.

The Mazda unit (with 6-volt, 108-watt bulb) is interchangeable with the arc and provides a steady and uniform light. The Mazda is always in alignment and is preferred by many because of its greater convenience and freedom from attention. As the intensity of the light from the Mazda is much less than from the Arc, the length of exposure must necessarily be longer. If the equipment is to be used for extended periods for observation only, this lamp is recommended.

Camera

The camera parts consist of a tapering bellows of 40″ extension, with front and rear supports and center frame to prevent sagging. The camera back is reversible and is provided with a hinged door, single book form of plate holder for 8 x 10 plates with reducing kits for smaller sizes down to 3¼ x 4¼, one ground glass screen with clear center for use with focusing glass and a clear glass screen with graduated cross lines. The front support is fitted with an exposure shutter and light tight connector for connecting with microscope. An extension rod for moving fine adjustment while observing the image on the ground glass and a focusing glass are included in the camera equipment.

The supporting base is made of two parts—a heavy steel bar for the camera parts and a section of accurately milled optical bed for the microscope. They are carefully joined together and provided with low supporting feet at either end. The supports for the camera slide very easily along the bar because of the long bearing surface and are prevented from tipping by a tongue running in a groove on the side of the bar. The bar is graduated in millimeters for the easy determining of bellows draw. The microscope and illuminating unit is clamped to the lathe bed by a heavy T bolt clamp.

New Focusing Camera Back

This new camera back (Figure 5) has been developed to make the focusing of the image easier and more positive, and to eliminate vibration in the manipulation of the dark slide.

It consists of a frame interposed between the rear bellows frame and the camera back proper, in which there is mounted a telescopic magnifier with a right angle prism which faces toward the eyepiece of the microscope. To focus one has but to look in the telescopic magnifier and adjust the fine adjustment of the microscope until the image is in focus on the cross hairs. As these are located the same distance from the prism as the plane of the plate, the image must be in focus in that plane. The telescopic magnifier is mounted on a pivot support so it may be moved across the entire field.

In this new back there is a supplementary dark slide which is raised by counter balanced weights running in cylinders on either side. With this device it is possible to withdraw the regular dark slide from the plate holder, permit the equipment to come to rest, check up on the focus with the telescopic magnifier, swing it aside, close the shutter, release the catch on the supplementary dark slide, permitting it to automatically rise without any vibration and then make the exposure. This arrangement will be readily appreciated by all photomicrographers. It can be attached to any of the type G cameras now in use.

Shock Absorbers

It is a recognized fact that the vibrations caused by machinery, street traffic, etc., must be absorbed before successful photomicrographs can be taken. The Bausch & Lomb Shock Absorbers (Figure 4) consist of four unit supports, each unit of which is made up of a sturdy frame, one coiled spring, a sponge rubber damper and a threaded secondary support for adjusting the pressure on the rubber damper or absorber.

Bausch & Lomb

Metallographic Outfit GB-ILSAA-9

featured by

1. Permanent alignment of microscope and illuminating unit.
2. Automatic Feed Arc Lamp that is interchangeable with Mazda unit.
3. Vertical Illuminator centered and set with reference to vertical axis.
4. Unit construction of stage and supporting frame.
5. Shock absorbers that retard, dampen and absorb vibrations.
6. Supplementary plate holder and device for viewing image when plate is in place.

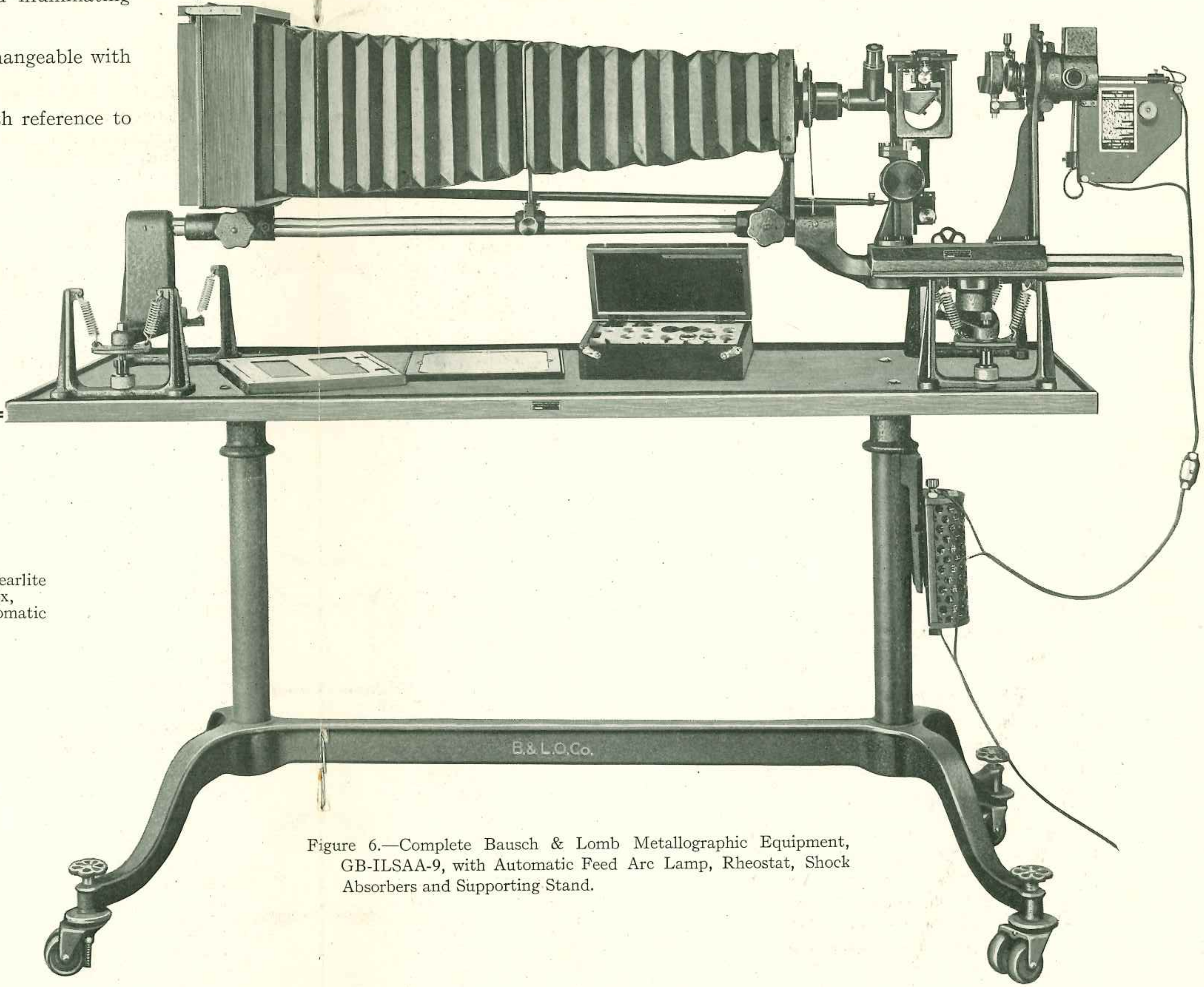


Figure 7.—Pearlite of Steel, 750x, 4 mm. Achromatic Objective.

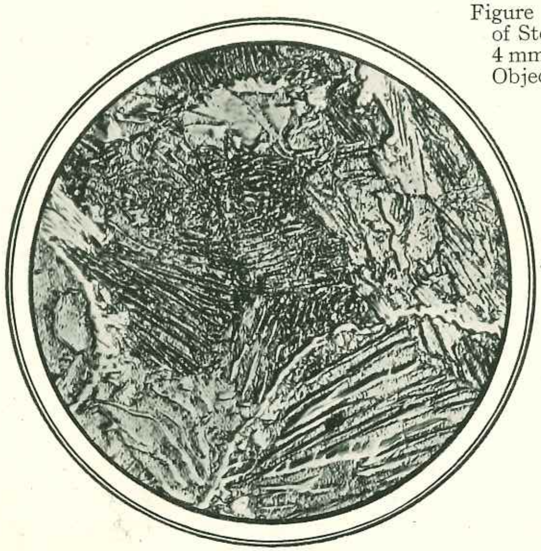


Figure 6.—Complete Bausch & Lomb Metallographic Equipment, GB-ILSAA-9, with Automatic Feed Arc Lamp, Rheostat, Shock Absorbers and Supporting Stand.

Supporting Stand

The top of the supporting stand measures 25 x 66″ and is 34″ above the floor. This large top at its convenient height will be appreciated by all users. The structural support is of cast iron with sturdy casters and leveling screws.

Objectives

The objectives offered for use with this equipment are all short mounted and corrected for use with uncovered objects. These may be of achromatic, fluorite or apochromatic type, all of which are corrected for a 215 mm. tube length. We suggest that the 16 and 8 mm. objective be of the achromatic construction and a selection made for the higher powers only.

Since it is customary in photographing iron and steel to use a filter that transmits light favorable to the correction of the achromatic objectives, excellent results can be secured with these, although for high magnification the fluorite or semi-apochromatic objectives will show improved image quality and excellent contrast. The apochromatic objectives which are corrected for all parts of the spectrum will be found particularly valuable in photographing alloys or heat tinted specimens where no filters are used.

Eyepieces

Hyperplane eyepieces which produce an exceptionally flat field are supplied as regular equipment for use with either achromatic or fluorite objectives, while the compensating eyepieces should be used with the apochromatic objectives for which they have been specially corrected.

Accessories for Macro-Photography

The increasing practice of photographing gross objects, fractures, deep etched specimens, etc., suggested the need of special accessories for that purpose. These accessories (Figures 8 and 9) consist of—

1. A cone shaped adapter with right angle prism attached to front standard of camera.
2. A micro Tessar Lens.
3. A supporting stage.
4. A clear glass vertical illuminator.
5. An illuminating unit with condensing system specially adapted for that purpose.

Figure 8 shows the arrangement for oblique illumination which is necessary for rough surfaces, such as fractured areas, while Figure 9 shows the clear glass vertical illuminator in position for use with large polished and etched surfaces.

The condensing system on the illuminating unit is composed of three elements of 4½″ diameter, so that it is possible to cover an unusually large field of a polished specimen—up to 35 mm. diameter with a 72 mm. micro tessar at approximately six magnifications. The illuminating unit is listed without the light source as the one on the ILS Metalloscope may be used interchangeably.

The specimen stage is adjustable by rack and pinion for focusing and may be operated by the extension focusing stick.

It may sometimes be desired to photograph large objects at natural size or reduction, in which case a longer focus lens is necessary, and such a lens is listed for that purpose. Other focal lengths of lenses may be had, depending on the requirements. Such a lens would be fitted in the rack and pinion focusing mount on the front of the camera. If the equipment is to be used to considerable extent for this purpose the GBV Camera, with the supplementary bar so the camera may be used in a vertical position, would be preferable. This would enable one to place the surface to be photographed in a horizontal position. If the camera is to be used vertically it may be placed on the floor with the set of shock absorbers. This advantage of this equipment will be appreciated at once.

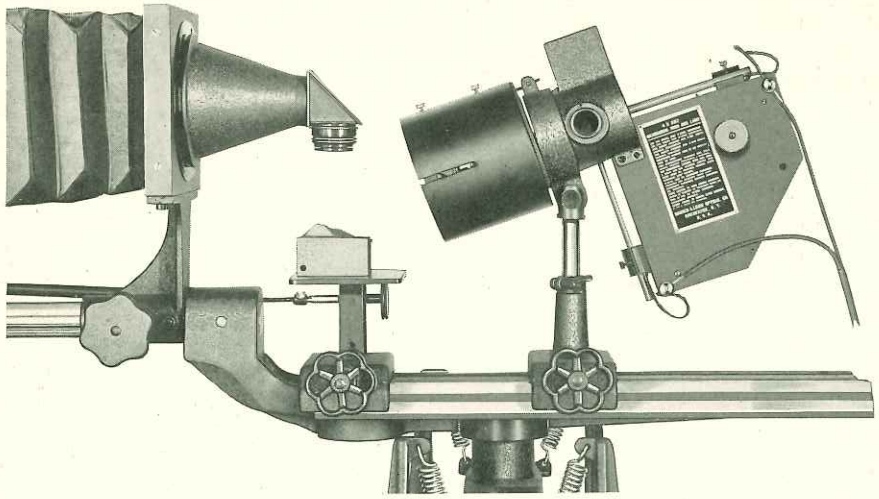


Figure 8.—Attachments for Macro-Photography, showing Arc lamp unit tilted for oblique illumination.

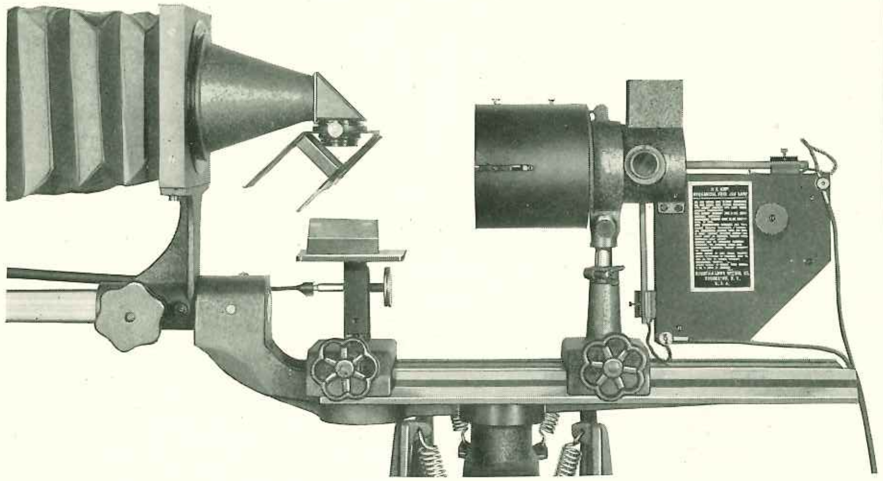


Figure 9.—Attachments for Macro-Photography, showing Arc lamp in position for vertical illumination.

SPECIFICATIONS AND PRICES

Code Word	Cat. No.	Metalloscope	Price
Camal	ILSAA	Metalloscope, including IL inverted microscope; vertical illuminator with side tube condenser diaphragm and ray filter; illuminating system, mounted on fixed support, on same base with microscope, consisting of triple condensing system with decentering iris diaphragm for oblique illumination and stops for conical illumination, water cell with ray filter holder, automatic feed arc lamp, rheostat for 4½-amperes, 110-volts and extension focusing stick.. Rheostat for 220-volts $3.75 extra. Specify if current is direct or alternating.	**$424.00**
Caegv	ILSR	Same as above, but with 6-volt, 108-watt ribbon filament Mazda lamp and transformer for 110-volt, 60-cycle alternating current..................................	**405.00**
		Camera	
Camem	GB	Camera consisting of section of optical bed and bar on low supporting feet; camera parts for 8 x 10 plates, with 40″ bellows draw, front, middle and rear supports, reversible camera back, single book form of plate holder with reducing kits down to 3¼ x 4¼, ground glass focusing screen with clear center, clear glass focusing screen, with graduated cross lines, exposure shutter, light tight connector and focusing glass............................	**258.00**
Camin	GBV	Camera, same as above, but with supplementary camera bar so camera may be used in vertical position. Desirable for use in photographing large objects with regular photographic lens attached to front of camera..............	**308.00**

Complete Metallographic Outfit

(Without Optical Equipment)

Code Word	Cat. No.	Specifications	Price
Camop	GB-ILSAA	Metallographic Outfit, complete, including GB camera and ILSAA Metalloscope as described............	**$682.00**
Camur	GB-ILSR	Same as above, but with ribbon filament lamp and transformer in place of arc lamp and rheostat.......	**663.00**

Optical Equipment

In order to give the user an opportunity to select the particular optical equipment desired, we have omitted objectives and eyepieces from the above specifications. Although objectives and eyepieces may be selected individually, we suggest the following combinations. When ordering equipment as listed below, add the numeral which designates the particular optical equipment desired to the catalogue number of the metallographic outfit selected. For example;—GB-ILSAA-9.

No. 9 Optical Equipment Code Word *Caeth* Price complete **$63.50**

Consisting of the following:

1—No. **1021-IL** Achromatic Objective, 16 mm.
1—No. **1027-IL** Achromatic Objective, 8 mm.
1—No. **1031-IL** Achromatic Objective, 4 mm.
2—No. **1162-IL** Hyperplane Eyepiece, 33 mm.
2—No. **1166-IL** Hyperplane Eyepiece, 20 mm.

No. 10 Optical Equipment Code Word *Caejv* Price complete **68.50**

Same as **No. 9**, but with No. **1060-IL** Fluorite Objective substituted for No. **1031-IL** Achromatic Objective. **No. 1060-IL** Fluorite Objective is of 4 mm.

Price List—Continued

No. 11 Optical Equipment Code Word *Caexl* Price complete **$116.50**

Same as **No. 10**, but with No. **1043-IL** Fluorite, oil immersion objective (1.8 mm.) added.

No. 12 Optical Equipment Code Word *Caezn* Price complete **170.50**

Consisting of the following:

1—No. **1021-IL** Achromatic Objective, 16 mm.
1—No. **1027-IL** Achromatic Objective, 8 mm.
1—No. **1131-IL** Apochromatic Objective, 4 mm.
1—No. **1141-IL** Apochromatic Objective, 2 mm.
1—No. **1202-IL** Compensating Eyepiece, 33 mm.
1—No. **1206-IL** Compensating Eyepiece, 20 mm.
1—No. **1162-IL** Hyperplane Eyepiece, 33 mm.
1—No. **1166-IL** Hyperplane Eyepiece, 20 mm.

NOTE: Hyperplane eyepieces are to be used in the tube connecting with the camera for the achromatic objectives, and the compensating are to be used for the apochromatic objectives.

Code Word	Cat. No.	Camera Back	Price
Canam	4618	Camera focusing back, consisting of frame to be inserted between bellows frame and reversible camera back, with counter balanced telescopic focusing magnifier and supplementary dark slide.............................	**$90.00**
		Supporting Stand	
Cairg	4665	Supporting stand with heavy cast iron base with levelling screws and castors, heavy supporting columns, and wooden table top..	**75.00**
		Shock Absorbers	
Cajik	4661	Set of shock absorbers consisting of 4 units, with single spiral spring and sponge rubber cushion with adjustable pressure on cushion..	**30.00**

Objectives

The objectives listed below are all short mounted and corrected for use without cover glass, for a tube length of 215 mm.

Achromatic Objectives

Code Word	Cat. No.	E. F. in mm.	N. A.	Working Distance	Price
Caivk	**1009-IL**	32	0.10	38.0 mm.	**$ 6.50**
Cafad	**1021-IL**	16	0.25	7.00	**8.00**
Cafef	**1027-IL**	8	0.50	1.6	**13.50**
Cafig	**1031-IL**	4	0.85	0.3	**15.00**
Cafoh	**1041-IL**	1.9	1.25	0.15	**35.00**

Fluorite Objectives

Code Word	Cat. No.	E. F. in mm.	N. A.	Working Distance	Price
Cafui	**1060-IL**	4	0.85	0.34 mm.	**$25.00**
Cagaf	**1043-IL**	1.8	1.30	0.13	**48.00**

Apochromatic Objectives

Code Word	Cat. No.	E. F. in mm.	Type of Objective	N. A.	Working Distance	Price
Cageg	**1131-IL**	4	Dry	0.95	0.18 mm.	**$52.00**
Cagih	**1141-IL**	2	Oil	1.30	0.12	**69.00**

Eyepieces

We are listing herein only the Hyperplane and Compensating eyepieces, since the Hyperplane is far superior to the regular Huygenian eyepieces for use with Achromatic Objectives for photomicrographic work. Also, the Compensating eyepieces must be used in conjunction with apochromatic objectives.

Hyperplane Eyepieces

Code Word	Cat. No.	Magnification No.	Approx. E. F. in mm.	Price
Cagoj	**1160**	5	50	**$5.50**
Caguk	**1162**	7.5	33	**5.50**
Cahag	**1164**	10	25	**8.00**
Caheh	**1166**	12.5	20	**8.00**
Cahij	**1168**	15	16.7	**8.00**
Cahok	**1170**	20	12.5	**8.00**

Compensating Eyepiece

Code Word	Cat. No.	Magnification No.	Approx. E. F. in mm.	Price
Cahul	**1200**	5	50	**$6.00**
Caibr	**1202**	7.5	33.3	**6.00**
Caics	**1204**	10	25	**8.50**
Caidt	**1206**	12.5	20	**8.50**
Caifv	**1208**	15	16.7	**8.50**
Caigw	**1210**	25	10	**8.50**

Stage Micrometer

Code Word	Cat. No.	Specifications	Price
Acoym	**1867**	Stage Micrometer of metal, with scale ruled to 0.1 and 0.01 mm. To be used in determination of exact magnification upon the ground glass..........................	**$16.00**

Micrometer Eyepiece

The micrometer eyepiece has been especially designed for use by metallographers in the measurement of grain size, depth of case hardening, etc. It has been designed for use with a 16 mm. objective on the IL Microscope, with which the resulting magnification is 100x. The micrometer scale is 0.04″ long, each graduation representing 0.001″ upon the specimen. Every fifth line is longer than the others and every tenth line is numbered. While this eyepiece has been especially designed for use on the IL microscope, it may be used on any regular metallurgical microscope with a 16 mm. objective, provided that the draw tube is set for a 215 mm. tube length, or at a magnification of exactly 100 diameters.

Code Word	Cat. No.	Specifications	Price
Caipf	**1852**	Micrometer Eyepiece, as described above................	**$12.00**

Macro Accessories

Code Word	Cat. No.	Specifications	Price
Caihx	**4650**	Cone Adapter fitting on front of camera with right angle prism and adapter to take 72 mm. micro Tessar........	**$30.00**
Caimc	**4655**	Reducing adapter for attaching 32 or 48 mm. micro Tessar to above...	**3.00**
Caikz	**4652**	Vertical illuminator with clear glass reflector for use with micro Tessars..................................	**7.50**
Canen	**4616**	Specimen support with rack and pinion for focusing......	**30.00**
Canip	**4571**	Illuminating Unit consisting of triple condensing system 4½″ diameter in mounting with clamping base and supporting column having adjustment for height and inclination. Without illuminant..........................	**40.00**
Dheft	**4401**	Micro Tessar 72 mm. focus............................	**44.00**
Dhegv	**4402**	Micro Tessar 48 mm. focus............................	**36.00**
Dhehw	**4403**	Micro Tessar 32 mm. focus............................	**36.00**
Haafb	**14***	Series Ic Tessar Lens 5½″ focus......................	**45.00**
Caasf	**4588**	Rack and pinion focusing mount fitting front board of camera fitted with adapter for No. 4401 72 mm. micro Tessar...	**12.00**
Caeds	**4589**	Reducing adapter to fit 4588 focusing mount when using 32 or 48 mm. micro Tessar............................	**2.50**
Caenc	**4589-A**	Reducing adapter to fit front of 4588 focusing mount and take No. 14 Ic Tessar lens...........................	**3.50**

*NOTE: We are suggesting this Tessar Ic lens as the one that is most generally suited for macro-photography, but we can supply a number of different focal lengths according to the size of field to be photographed, magnification or reduction required, etc.

Oblique and Conical Illuminator

This attachment, together with the water cell, may be fitted to ILS microscope already in use.

Code Word	Cat. No.	Specifications	Price
Canor	**4620**	Oblique and conical illuminator consisting of support attaching to front of condenser mount, an iris diaphragm in rotating mount and decenterable by rack and pinion for oblique illumination; two central stops for conical illumination and bracket for holding water cell............	**$25.00**
Canus	**4686**	Water cell with filter holder for 2″ sq. Wratten "M" filters..	**10.00**

Filters

For those desiring filters other than the one regularly attached to the vertical illuminator, we suggest one or more of the Wratten "M" filters as listed below. These are composed of gelatin sheets stained with appropriate dyes cemented between glass plates 2″ square.

Code Word	Name of Filter	Visual Color	Spectral Transmission	Price
Caobs	A	Scarlet	From 5800 to Red End	Net **$1.40**
Caoct	B	Green	From 4600 to 6000	Net **1.40**
Caodw	C	Blue-violet	From 4000 to 5100	Net **1.40**
Caofw	D	Purple	From 3800 to 4600	Net **1.40**
Caohy	E	Pure Red	From 5600 to Red End	Net **1.40**
Caojz	F	Strong Yellow	From 6100 to Red End	Net **1.40**
Caokb	G	Blue	From 5100 to Red End	Net **1.40**
Caole	H	Pale Yellow	From 4200 to 5400	Net **1.40**
Caomd	K	Yellow		Net **1.40**

Caonf, complete set of "M" filters as listed above, in case, Net **$16.00**

Price List—Continued

Lamps

Code Word	Cat. No.	Specifications	Price
Diogz	4485	Automatic feed (clock work) arc lamp with housing for attaching any of standard illuminating units with removable light sources, without rheostat. Instructions for use on name plate	$35.00
Caitj	4596-R	6-volt 108-watt ribbon filament Mazda lamp in housing to fit standard illuminating units and transformers for 110-volts 60 cycles A. C.	26.00
Aczaf	1824	6-volt 108-watt ribbon filament Mazda lamp, bulb only	6.00
		RHEOSTATS AND TRANSFORMERS	
Detol	4452	Rheostat for arc lamp for 4½ amperes, with connecting posts for 100, 105 and 110 line voltage	10.00
Detum	4453	Rheostat for arc lamp for 4½ amperes 220 line voltage	13.75
Dewup	4497	Transformer for 6-volt 108-watt Mazda lamp 110-volt 60-cycle alternating current	10.00
Dimem	4497-A	Transformer same as above, but for 220-volts	17.50

Transformers for 25 cycles, 110-volts can be supplied at $7.50 extra and must be specified when ordering.

Carbons

Code Word	Cat. No.	Specifications	Price
Dezep	4472	8 mm. diameter, 6″ long cored positive carbon for direct current per ten	$0.40
Dezir	4473	6 mm. diameter, 6″ long cored negative carbon for direct current per ten	.40
Diofy	4481	7 mm. diameter, 6″ long cored for both electrodes on alternating current per ten	.40

Focusing Glass

When focusing upon images of very minute structures, the eye requires some assistance in order to determine the sharpest point. For this purpose a focusing glass should be used.

No. 4545 is a double lens, consisting of two plano-convex lenses. The combination gives an equivalent focus of 38 mm. It is mounted with screw adjustment for focusing.

Code Word	Cat. No.	Specifications	Price
Cakaj	4545	Doublet Focusing Glass, as described	$4.00

Plate Holders

Code Word	Cat. No.	Specifications	Price
Caizp	4632	Single, for 8 x 10″ plates, including a set of kits for any size negative from 3¼ x 4¼″ up to 8 x 10″	$7.00
Cakom	4548	Double, for 8 x 10″ plates	2.75
Cakum	4549	Double, for 8 x 10″ plates, with kits for 5 x 7″	3.65
Calak	4553	Double, for 8 x 10″ plates, with kits for 5 x 7 and 4 x 5″	4.25
Calel	4554	Double, same as 4553, but with kits for 3¼ x 4¼″ in addition	4.85

Price List—Concluded

Recommended Complete Equipments

No. 1—Equipment for range of magnification between 100 and 1,000 diameters.

GB-ILSAA Metallographic Outfit	$682.00
No. 9 Optical Equipment	63.50
4665 Supporting Stand	75.00
4661 Set of Shock Absorbers	30.00
25 pairs of carbons	2.00
	$852.50

No. 2—Equipment for range of magnification from 100 up

Same as above, but substituting No. 11 optical equipment in place of No. 9	$905.50

No. 3—Equipment including accessories for Macro Photography and other desirable accessories.

GB-ILSAA Metallographic Outfit	$682.00
4595 Mazda lamp attachment if alternating current is available	26.00
4618 Focusing Camera Back	90.00
4665 Supporting Stand	75.00
4661 Shock Absorbers	30.00
2 Single Book form plate holders	14.00
No. 11 Optical Equipment	116.50
1867 Stage Micrometer	16.00
1852 Micrometer Eyepiece	12.00
25 pairs Carbons	2.00

Macro Accessories

4650 Cone Adapter and prism	30.00
4652 Clear Glass vertical illuminator	7.50
4616 Specimen Support	30.00
4571 Illuminating Unit	40.00
4401 72 mm. Micro Tessar	44.00
	$1,215.00

No. 4—Equipment the same as No. 3, but with the following additions:

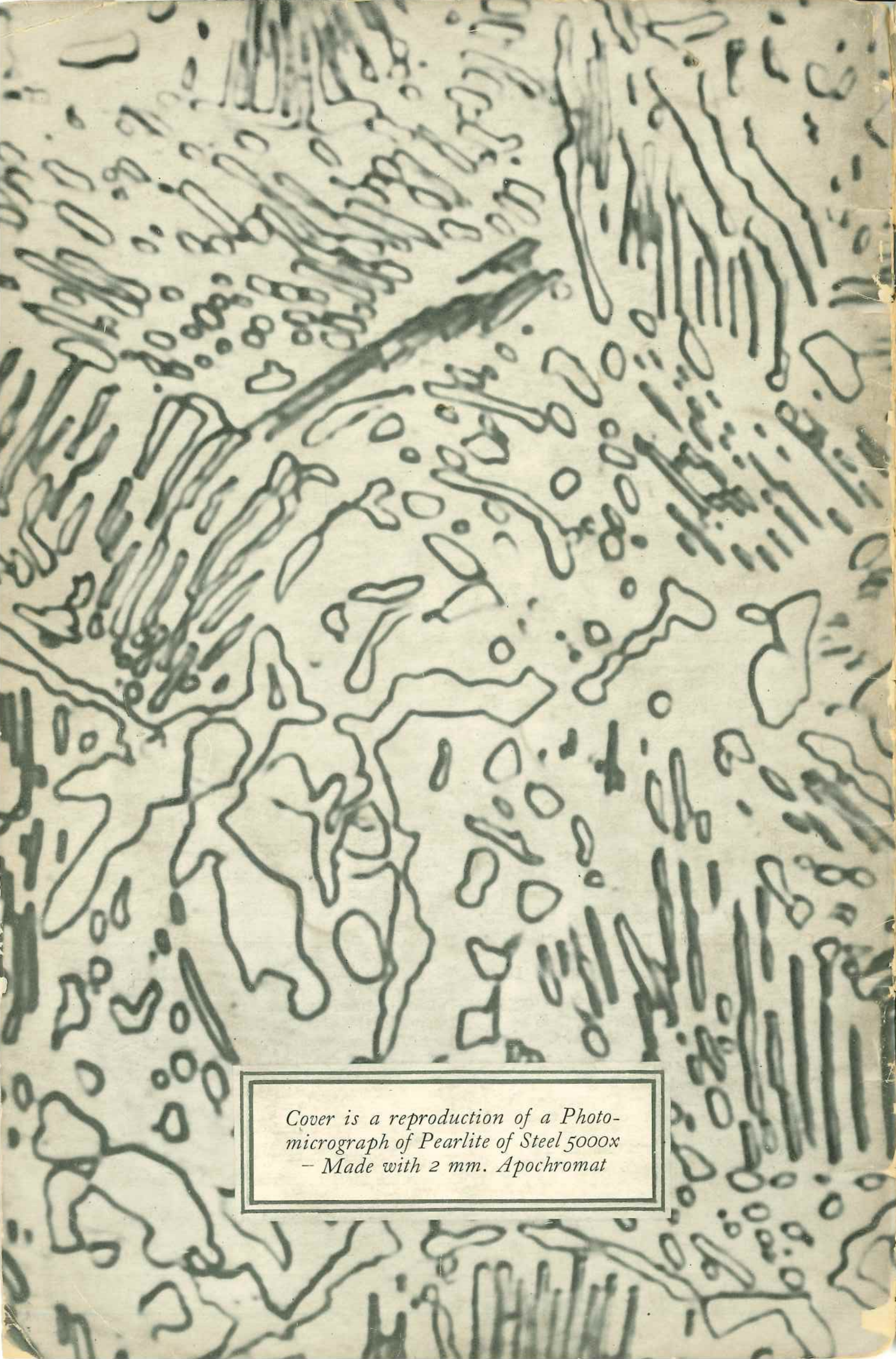
GBV Camera in place of GB camera extra	$50.00
No. 14 Ic Tessar Lens	45.00
4588 Rack and Pinion focusing mount	12.00
4589-A Reducing Adapter	3.50
	$1,325.50

(Partial list of users on next page)

Partial List of Users

Alaska Agricultural College and School of Mines, College Sta., Alaska
Pacific Malleable Castings Co., Oakland, Calif.
Ford Motor Co., Ford, Ont., Canada
The Steel Co. of Canada, Ltd., Hamilton, Ont., Canada
Canadian General Electric Co., Toronto, Ont., Canada
Hydro Electric Power Com., Toronto, Ont., Canada
University of Toronto, Toronto, Ont., Canada
Dept. of Mineralogy
Dept. of Metallurgy
Naugatuck Malleable Iron Works, Union City, Conn.
American Chain Co., Bridgeport, Conn.
Bridgeport Brass Co., Bridgeport, Conn.
Remington Arms Co., Bridgeport, Conn.
New Departure Mfg. Co., Bristol, Conn.
J. M. Ney Co., Hartford, Conn.
Whitney Mfg. Co., Hartford, Conn.
Geometric Tool Co., New Haven, Conn.
American Brass Co., Waterbury, Conn.
Scovill Mfg. Co., Waterbury, Conn.
Bureau of Standards, Washington, D. C.
Department of Interior, U. S. Geological Survey, Washington, D. C.
Department of Interior, U. S. Geological Survey, Alaska Division, Washington, D. C.
Navy Department, Washington, D. C.
War Department, Cannon Section, Washington, D. C.
Georgia Institute of Technology, Atlanta, Ga.
American Steel Foundries, Chicago, Ill.
Criggin Wheel Co., Chicago, Ill.
A. H. Finkel & Sons Co., Chicago, Ill.
Illinois Malleable Iron Co., Chicago, Ill.
Illinois Central Railroad, Chicago Ill.
Illinois Tool Works, Chicago, Ill.
Lewis Institute, Chicago, Ill.
American Manganese Steel Co., Chicago Heights, Ill.
Western Cartridge Company, East Alton, Ill.
Rich Tool Company, Chicago, Ill.
Holt Manufacturing Co., East Peoria, Ill.
Walworth Mfg. Company, Kewanee, Ill.
Illinois Zinc Company, Peru, Ill.
Pullman Car and Mfg. Co., Pullman, Ill.
Acme Steel Goods Co., Andesdale, Ill.
Rockford Malleable Iron Works, Rockford, Ill.
National Lock Co., Rockford, Ill.
American Steel and Wire Company, Waukegan, Ill.
Interstate Iron and Steel Co., E. Chicago, Ind.
Inland Steel Company, Ind. Harbor, Ind.
Midwest Engine Company, Indianapolis, Ind.
Munsie Products Division of G. M. Corp., Muncie, Ind.
Indiana Steel and Wire Company, Muncie, Ind.
Iowa Malleable Iron Company, Fairfield, Iowa
State University of Iowa, Iowa City, Iowa
Wadsworth Watch Case Company, Dayton, Kentucky
New Orleans Public Service, Inc., New Orleans, La.
University of Maine, Orono, Maine
Baltimore Copper Smelting and Rolling Company, Baltimore, Maryland
U. S. Naval Academy, Annapolis, Maryland
War Department, Edgewood, Maryland
Harvard University, Mining and Metallurgical Laboratory, Cambridge, Mass.
Wentworth Institute, Boston, Mass.
Mass. Inst. of Technology, Cambridge, Mass.
Chapman Valve Mfg. Co., Indian, Mass.
U. S. Cartridge Company, Lowell, Mass.
General Electric Company, Pittsfield, Mass.
Springfield Armory, Springfield, Mass.
Watertown Arsenal, Watertown, Mass.
American Steel and Wire Co., Worcester, Mass.
Norton Company, Worcester, Mass.
Reed & Prince, Worcester, Mass.
Wyman Gordon Company, Worcester, Mass.
Hoover Steel Ball Company, Ann Arbor, Michigan.
University of Michigan, Ann Arbor, Michigan
Rich Steel Products Company, Battle Creek, Michigan
American Auto Parts Company, Detroit, Michigan
American Twist Drill Company, Detroit, Michigan
Chicago Pneumatic Tool Company, Detroit, Michigan
Detroit Brass and Malleable Co., Detroit, Michigan
Ford Motor Company, Dearborn, Mich.
Detroit Twist Drill Company, Detroit, Michigan
General Motors Co., Central Laboratory, Detroit, Michigan
Hupp Motor Corporation, Detroit, Michigan
Packard Motor Car Company, Detroit, Michigan
Studebaker Corporation, Detroit, Michigan
Victor Peninsular Company, Detroit, Michigan
Michigan Agricultural College, East Lansing, Michigan
Buick Motor Company, Flint, Michigan
Olds Motor Works, Lansing, Michigan
Reo Motor Car Co., Lansing, Michigan
C. H. Wills & Company, Marysville, Michigan
Dow Chemical Company, Midland, Michigan
Continental Motors Corp., Muskegon, Michigan
Oakland Motor Car Company, Pontiac, Michigan
Saginaw Malleable Iron Co., Saginaw, Mich.
Saginaw Products Co., Saginaw, Mich.
Minneapolis Steel and Machinery Company, Minneapolis, Minnesota
University of Minn., Dept. of Metallurgy, Minneapolis, Minnesota
Northern Pacific Railroad Co., St. Paul, Minnesota
Montana State School of Mines, Butte, Montana
Missouri School of Mines, Rolla, Missouri
Washington University, St. Louis, Missouri
Union Pacific Railroad Co., Omaha, Nebraska
Standard Oil Company, Bay Way Refineries, Elizabeth, New Jersey
Singer Sewing Machine Co., Elizabethport, New Jersey
American Can Co., Newark, New Jersey
British American Metals Co., Plainfield, New Jersey

Princeton University, Princeton, New Jersey
Ramsey Chain Co., Inc., Albany, New York
Enrique Touceda, Albany, New York
Penn Spring Works, Baldwinsville, New York
Quasi-Arc Weltrode Co., Brooklyn, New York
American Safety Razor Corp., Brooklyn, New York
A. Schrader's Sons, Inc., Brooklyn, New York
Curtis Areoplane and Motor Corp., Buffalo, New York
Donner Steel Company, Buffalo, New York
Sizer Forge Company, Buffalo, New York
J. H. Williams Company, Buffalo, New York
University of Buffalo, Buffalo, New York
The Willys-Morrow Company, Elmira, N. Y.
Curtis Eng. Corp., Garden City, L. I., N. Y.
Remington Typewriter Co., Ilion, N. Y.
Cornell University, Ithaca, New York
Simonds Mfg. Company, Lockport, New York
Clemson Bros., Inc., Middletown, New York
Electro Metallurgical Co., L. I. City, N. Y.
Cooper Union Institute, New York, N. Y.
Ledoux & Company, New York, New York
New York Testing Laboratories, New York, New York
Niles-Bement-Pond Company, New York, New York
Supply Officer, N. Y. Navy Yard, New York, New York
S. S. White Dental Mfg. Co., Princess Bay, Staten Island, New York
Gleason Works, Rochester, New York
The Pfaudler Company, Rochester, N. Y.
North East Electric Company, Rochester, N. Y.
Taylor Instrument Company, Rochester, N. Y.
Rome Mfg. Company, Rome, New York
Rome Wire Company, Rome, New York
Brown-Lipe-Chapin Company, Syracuse, N. Y.
Crucible Steel Company, Syracuse, New York
Frazer Jones, Syracuse, N. Y.
Solvay Process Company, Syracuse, N. Y.
Rensselaer Polytechnic Institute, Troy, N. Y.
Ludlum Steel Company, Watervliet, N. Y.
Watervliet Arsenal, Watervliet, New York
University of Akron, Akron, Ohio
Morgan Eng. Company, Alliance, Ohio
Ohio University, Athens, Ohio
Ohio Insulator Co., Barberton, Ohio
United Alley Steel Corporation, Canton, Ohio
Case School of Applied Science, Cleveland, Ohio
Champion Machine & Forging Co., Cleveland, Ohio
General Electric Co., Incandescent Lamp Works, Cleveland, Ohio
Elyria Iron and Steel Co., Cleveland, Ohio
McKinney Steel Co., Cleveland, Ohio
National Malleable Casting Co., Cleveland, Ohio
National Screw and Tack Co., Cleveland, Ohio
Midland Steel Products Co., Cleveland, Ohio
Standard Tool Company, Cleveland Ohio
Steel Improvement and Forge Co., Cleveland, Ohio
Steel Products Company, Cleveland, Ohio
Torbensen Axle Company, Cleveland, Ohio
Western Reserve University, Cleveland, Ohio
Buckeye Steel Casting Co., Columbus, Ohio
Ohio State University, Columbus, Ohio
General Motor Company, Research Department, Dayton, Ohio
National Cash Register Co., Dayton, Ohio
University of Dayton, Dayton, Ohio
War Department, Air Service, Dayton, Ohio
Bourne Fuller Company, Cleveland, Ohio
Lima Locomotive Works, Lima, Ohio
American Rolling Mill Co., Middletown, Ohio
Oberlin College, Oberlin, Ohio
Woodward Tech. H. S., Toledo, Ohio
National Supply Co., Toledo, Ohio
Follansbee Bros. Co., Toronto, Ohio
Trumbull Steel Company, Warren, Ohio
Youngstown Sheet and Tube Company, Youngstown, Ohio
American Nickel Corp., Clearfield, Pa.
Bethlehem Steel Co., Coatesville, Pa.
Allan Wood Iron and Steel Company, Conshohocken, Pa.
Erie Forge Company, Erie, Pa.
Erie Malleable Iron Company, Erie, Pa.
Latrobe Electric Steel Co., Latrobe, Pa.
Allegheny College, Meadville, Pa.
Aluminum Company of America, New Kensington, Pa.
The Hess-Bright Mfg. Co., Philadelphia, Pa.
Lanston Monotype Machine Company, Philadelphia, Pa.
Leeds & Northrup, Philadelphia, Pa.
Supply Office Navy Yard, Philadelphia, Pa.
Tacony Ordnance Corporation, Philadelphia, Pa.
S. S. White Dental Mfg. Co., Philadelphia, Pa.
American Bridge Co., Pittsburgh, Pa.
American Steel and Wire Co., Pittsburgh, Pa.
Braeburn Steel Corporation, Pittsburgh, Pa.
Carnegie Institute of Technology, Pittsburgh, Pa.
Oil Well Supply Company, Pittsburgh, Pa.
Heppenstall Knife and Forge Co., Pittsburgh, Pa.
Standard Chemical Company, Pittsburgh, Pa.
University of Pittsburgh, Pittsburgh, Pa.
Westinghouse Electric and Mfg. Co., E. Pittsburgh, Pa.
The Carpenter Steel Company, Reading, Pa.
Philadelphia and Reading Ring Co., Reading, Pa.
Valley Mold and Iron Corporation, Sharpsville, Pa.
Jessop Steel Company, Washington, Pa.
American Electrical Works, Phillipsdale, R. I.
Rival Safety Razor Corporation, Dallas, Texas
Bureau of Ordnance, Metallurgical Lab., Norfolk, Pa.
Puget Sound Navy Yard, Bremerton, Wash.
University of Washington, Seattle, Wash.
Follansbee Bros. Co., Follansbee, W. Va.
International Nickel Co., Huntington, W. Va.
West Virginia University, Dept. of Chemical Eng., Morgantown, W. Va.
Weirton Steel Company, Weirton, W. Va.
The Falk Company, Milwaukee, Wis.
International Harvester Co., Milwaukee, Wis.
Milwaukee Electric Railway and Light Co., Milwaukee, Wis.
Kohler Co., Sheboygan, Wis.
Milwaukee Steel Foundries Co., Milwaukee, Wis.
Waukesha Motor Company, Waukesha, Wis.



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